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that, whereas anesthetics may induce surface changes assumed to be associated with permeability, they are active on the inside of the cell as evidenced in shrinkage of chloroplasts. Anesthetics affect different cell activities differently. This may be due to effects on different cell structures : plasma membrane, chloroplasts and cytoplasm.

A GENERAL SINKING OF SEA-LEVEL IN RECENT TIME

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Communicated by J. M. Clarke, March 10, 1920

Among the causes of world-wide or "eustatic" shifts of sea-level are: appropriate crustal movements whereby the volume of the ocean basin is changed; delta-building and volcanic extravasation on the sea-floor, the displacement of sea-water not being compensated by crustal subsidence; volcanic addition of new water to the ocean; subtraction of water which becomes chemically bound during the alteration of rocks; glaciation on land, lowering sea-level by the abstraction of water from the ocean; deglaciation on land, raising sea-level; changes in the earth's center of gravity and in her speed of rotation. Numerous as these possibilities are, eustatic shifts at definite times and in definite amounts have not often been postulated by geologists. The proof of such a shift, either positive or negative, is not easy. The present note records some field facts suggesting the probability of a sinking of general sea-level to the extent of nearly 20 feet, during the Human period. The suggestion is published, not to express a fixed conclusion but to invite criticism by those familiar with shore-lines in different parts of the world, for its testing is manifestly a world-wide problem. The matter is important because it affects judgment as to the reality of many so-called uplifts of land or sea-bottom, and because a close study of the latest shift of sea-level may help to systematize the criteria for earlier and larger eustatic shifts.

Nearly twenty years ago the hypothesis of a recent, negative movement of sea-level first presented itself to the writer while engaged in the correlation of post-Glacial elevated strands in Labrador and Newfoundland with those of Quebec. The highest strand mapped between Newfoundland and Nachvak Bay, 500 miles to the northwest, was found to be strongly warped, like the highest strand from Newfoundland to Massachusetts. On the other hand, the lowest emerged terrace along the shores of the Gulf of St. Lawrence was seen to be conspicuously level throughout a distance of 300 miles or more below Quebec City. This apparent uniformity of level prompted the question whether this particular strand had been abandoned by the waves because of a sinking of general sea-level. For lack of accurate leveling, correlation with the more closely studied, lowest

beaches of Labrador was impossible, and with the data in hand serious belief in the hypothesis of a eustatic change was withheld.

However, that explanation was recalled by the discovery of new facts during recent field studies on the shores of New England, Florida, and the Samoan Islands. Meantime Goldthwait had made a careful study of the St. Lawrence strand, to which he gave the name "Micmac terrace;" the results of his leveling agree so well with those made in the other regions mentioned that the suspicion of past years became a hypothesis deserving more attentive consideration.

For the opportunity to collect data from the two tropical regions the writer is indebted to Dr. A. G. Mayor, Director of the Marine Laboratory of the Carnegie Institution of Washington.

In his excellent account of the Micmac terrace, Goldthwait noted the nearly uniform level of its inner edge at about 20 feet above high tide, as well as its relatively great strength and continuity, with width varying from a few feet to 1.5 miles or more. Though only a part of its width is due to wave-cutting and though the formations affected are weak, the higher level of the sea must have been steadily kept for a large fraction of post-Glacial time.¹ Farther east in the Gulf of St. Lawrence, on Anticosti, and again in Nova Scotia, Twenhofel has found wide terraces at about the same level.²

A similar feature characterizes the coast of Maine, as emphasized in the folios and monographs of the United States Geological Survey and as confirmed by the present writer.

Mayor had already found wave-cut rock benches, about 8 feet above high tide on all sides of Tutuila, the largest island of American Samoa.³ The island is 16 miles long. At its eastern end is Aunuu island, and about 60 miles farther east is Tau island of the Manua group. The writer found very fine wave-cut benches at 8 to 10 feet above high tide on Aunuu and Tau, and others at the same general elevation on Olosega island, 7 miles west of Tau. The distance between the most widely separated benches is 75 miles; nowhere in that long stretch did the bench crests depart essentially from a constant level. Explanation by local uplift was at once seen to be highly improbable, for crustal uplift of such uniformity is unknown to geology.

Eight or ten feet of bench elevation does not, however, measure the total of recent emergence in Samoa. At several points in Tutuila large sea-caves were found. Their floors varied in height, from 14 or 15 feet at their mouths to 25 feet at the back walls of the caves. Many caves of similar forms and cut in similar rocks are being made by the surf of the present day. The lower lips of these newer caves are characteristically 4 to 6 or more feet below high-tide level and the floors rise inwards to heights of a few feet above high tide. Hence, the emerged caves were cut when the sea-level was nearly 20 feet higher than now. That assump-

tion also explains the 8-foot benches, for the cliffs now being cut on the Samoan headlands (where not protected by coral reefs) have regularly about 12 feet of water directly at their feet during high tide. The writer fully agrees with Mayor's conclusion that reef corals were not living on any of these Samoan shores when the emerged caves and benches were developed. Hence, the nearly or quite reefless headlands of the present time are those where the relation between sea-level and bench-level of the earlier period is best determined.

Correlation of the Samoan and North American terraces was suggested not only by the agreement in level but also by the state of preservation of the strand-marks, as well as by the comparable amounts of work done by the waves in the two regions during the higher stand of the sea.

The hypothesis of a eustatic shift must obviously meet the test of matching the facts observable on the shores of every continent and of most islands. The application of the test is difficult for many reasons which need not here be recounted, but a partial study of the records scattered through geological literature shows that the hypothesis merits discussion and further testing. The actual compilation of facts relates to the British Isles, the Atlantic coast of North America south of New York, the West Indies, Brazil, Patagonia, Antarctica, New Zealand, Australia, and many groups of the Pacific islands. For details the reader is referred to an article in a forthcoming number of the *Geological Magazine* (London).

A specially instructive example is seen in the agreement of the lower Cape May terrace of New Jersey and Pennsylvania, the Talbot terrace of Maryland (marine part), the Satilla terrace of Georgia, and the lower Pensacola terrace of Florida in age, height and strength of development, both among themselves and with the other terraces above-mentioned. The Pensacola-Satilla terrace alone keeps a practically uniform set of levels (maximum about 20 feet) for an air-line distance of 500 miles; the explanation of its emergence by crustal uplift seems hardly credible.

According to Andrews, "indications of the apparent elevation of the shore-line for a few feet are to be found along the whole eastern side of Australia;" he attributes the cause to "either an apparent rise of the land, or a retreat of the sea."⁴ Süssmilch specifies the amount of the emergence (New South Wales) as "10 to 20 feet."⁵ Cadell notes similarly recent emergence of western Australia by amounts between the same limits.⁶ In this case nearly or quite uniform emergence has affected a thousand miles of coast on one side of a continent and several hundred miles on the other side, and again there is practical agreement with the amount of emergence shown in the mid-Pacific, in North America, and in many other regions.

Thus, in spite of complications, including the present-day warping of some coasts, the hypothesis appears to stand the test involving the amounts of local emergence.

A second test naturally inheres in the expectation that the deleveling should be synchronous in all parts of the ocean. Observers dwell on the recency of the sea-level shifts registered in all of the cases compiled. Fossils from the St. Lawrence, Scottish, Irish, Cuban, Patagonian, New Zealand, Australian, Funafuti, Murray Island, New Jersey, Maryland, Georgia, and Florida beaches, reefs, or coastal plains belong to species now living in the adjoining seas, or, exceptionally, to species now living in slightly warmer water. Great recency is also shown by the relatively small damage done by erosion to the strand-marks, except in the case of those exposed to powerful surf. The beaches of the higher latitudes are clearly post-Glacial and also of later dates than the post-Glacial uplifts following the melting of the ice-caps. Brögger puts the completion of the last 4-meter to 8-meter emergence of the Christiania region at about the year 500 B.C. The development of the corresponding sea-cliffs, benches, and other strand-marks is referred by him to the late Tapes (Neolithic) period, between 1400 B.C. and 2400 B.C. During late Tapes time the Christiania sea was about 2° C. warmer than now.⁷ The fossils in the Patagonian beaches also betoken water warmer than the adjacent sea.

Simultaneous emergence of the many separate regions is the more credible because of the similarity in the histories of their respective coasts before emergence. Repeatedly one encounters the description of terrace, bench or beach near the 20-foot level as the best developed, the most conspicuous, of the most persistent in areas characterized by "raised" strand-marks. One may conclude that the different regions must have had sea-level nearly constant for a considerable time, during which the strand-marks were well incised or built up. Such widespread accordant itself must deepen suspicion that local deformations of the earth's crust have not been responsible for the recent emergence of so many continental and island coasts.

In conclusion, the facts at hand seem to permit belief in the synchrony of the different strand-markings and emergences here considered, but this second test of the hypothesis clearly demands further investigation.

Before the fact is established, it would be idle to dwell overmuch on the explanation of a 20-foot drop in the level of the ocean. The most promising idea appears to be that a few thousand years ago there was an increase in the volume of the existing, non-floating glaciers. If the Antarctic ice-cap were then thickened to the average amount of about 700 feet, an average sinking of sea-level to the extent of nearly 20 feet would be inevitable. In favor of this suggestion would be evidence of a world-wide oscillation of climate like that which seems to have affected the Christiania region in Recent time. If the whole earth was, in the Tapes period, a little warmer than now, less water may have been taken from the ocean to constitute the ice-caps; sea-level was a little higher than at present. The

oscillation as a whole would be but an incident in a series of climatic and oceanic changes which began with the opening of the Glacial period.

¹ Goldthwait, J. W., *Amer. J. Sci.*, **32**, 1911 (293).

² Twenhofel, W. H., *Ibid.*, **28**, 1909 (147); **30**, 1910 (66, 69).

³ Mayor, A. G., *These PROCEEDINGS*, **3**, 1917 (523).

⁴ Andrews, E. C., *New South Wales Handbook*, Brit. Assoc. Adv. Sci., 1914 (525, 532).

⁵ Süssmilch, C. A., *Introduction to the Geology of New South Wales*, Sydney, 1911 (154).

⁶ Cadell, H. M., *Trans. Edinburgh Geol. Soc.*, **7**, 1897 (179).

⁷ Brögger, W. C., *Norges geol. Unders.*, No. 31, 1901 (713), and No. 41, 1905.

A NOTE ON THE HUMAN SEX RATIO

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From data collected at the Sloane Maternity Hospital in New York City, it has recently been shown¹ that there is a significantly higher male sex ratio at birth among progeny whose parent are not of similar nationality. This result confirmed a paper published by the Pearls² in 1908, based on data derived from vital statistics of the City of Buenos Ayres, and had in addition a decreased source of error due to improved methods of recording the data and the inclusion of still births as well as living births in the calculations.

During the past year, a further study of the same records has been made concerning the sex ratio among the progeny of certain other types of matings and a preliminary attempt at analysis made by contrasting the sex ratios of the offspring of *primipara* with those of subsequent births.

Table 1 shows the sex ratios of five categories of matings: European "pure," European "hybrid," United States white, British West Indies colored, and United States colored. European pure are matings in which both parents were of the same nationality. European hybrids are offspring whose parents are of different nationality, United States white include a random sample of parents coming from various parts of the United States but preponderantly from the East and especially from New York State and New York City. British West Indies colored, are offspring from colored parents born in the British West Indies, and United States colored are offspring from colored parents born anywhere in the United States.

In each case the probable error of the ratio obtained has been calculated for the numbers observed. On the basis of these probable errors, the differences between the various ratios can be fairly compared with respect to their probable significance.

As has before been shown, there is a significant difference between the European "pure" and the European "hybrid" and between the former